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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/776,329	02/02/2001	Sean M. Seutter	AMAT/5192/ISM/CORE MCVD/S	9575

32588 7590 07/30/2003

APPLIED MATERIALS, INC.
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SANTA CLARA, CA 95050

EXAMINER	
THOMAS, TONIAE M	

ART UNIT	PAPER NUMBER
2822	

DATE MAILED: 07/30/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/776,329	SEUTTER ET AL.	
	Examiner	Art Unit	
	Toniae M. Thomas	2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 May 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-50* is/are pending in the application.

4a) Of the above claim(s) *29-31 and 48-50* is/are withdrawn from consideration.

5)☒ Claim(s) *4-8,16-23 and 32-47* is/are allowed.

6)☒ Claim(s) *1,2,9,10 and 24-28* is/are rejected.

7)☒ Claim(s) *3 and 11-15* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *8* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Introduction

1. This action is an official response to the amendment received on 02 May 2003. Currently, claims 1-50 are pending. Claims 29-31 and 48-50 have been withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made without traverse in Paper No. 6.

Withdrawal of Rejections

2. Applicant's arguments, see page 12, paragraph B to page 13, paragraph C, filed 02 May 2003, with respect to the rejection of claims 1-3, 9-15, 35-37, and 39-43 under 35 USC 102(e) and the rejection of claims 24-25, 27-28, and 45-46 under 35 USC 102(e) have been fully considered and are persuasive. Review of provisional Application 60/251,795 to which Chiang et al. claims priority does not provide support for the subject matter relied upon to make the rejections. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Gates et al. (US 6,203,613 B1).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless -

> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. *Claims 1, 2, 9, and 10 are rejected under 35 U.S.C. 102(e) as being anticipated by Gates et al. (US 6,203,613 B1).*

The Gates et al. patent discloses a method of depositing a metal nitride film for an integrated circuit, wherein atomic layer deposition (ALD) is used to deposit the metal nitride film (col. 5, line 55 – col. 7, line 42 and col. 10, lines 25-52). In one embodiment, the metal nitride film is tantalum nitride (col. 10, lines 48-52). In this embodiment, $Ta(NO_3)_5$ is used in place of $Ti(NO_3)_4$ as the first reactive gas. The method comprises: providing a chamber in a process system (col. 10, lines 36-37); placing a substrate in the process chamber (col. 10, lines 36-37); providing a first reactive gas to the chamber (col. 10, line 41);[1] chemisorbing a first layer on the substrate in partial response to the first reactive gas;[2,3] conditioning the chamber with a purge gas (col. 10, line 42); providing a second reactive gas, NH_3, to the chamber (col. 10, line 43);

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[1] As stated above, in the embodiment where the metal nitride film is TaN, $Ta(NO_3)_5$ is used in place of $Ti(NO_3)_4$ as the first reactive gas.

[2] Since ALD is used to deposit the metal nitride film, chemisorption of a first layer on the substrate in partial response to the first reactive gas is inherent.

[3] Since the first reactive gas is a tantalum-containing gas, it is inherent that the first layer is a tantalum layer.

and chemisorbing a second layer on the first layer, wherein the second layer is different from the first.[4,5]

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. *Claims 24, 25, 27, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami et al. (US 6,001,415) in view of Gates et al.*[6]

The Nogami et al. patent discloses a method for forming a barrier layer structure and an interconnect structure for use in an integrated circuit (figs. 1-7 and accompanying text). The method comprises the steps of: providing a substrate having a dielectric layer 24 thereon, wherein the dielectric layer has a recess formed to expose a portion of a surface of the substrate (fig. 3); forming a barrier layer 42 on the dielectric layer and the substrate (fig. 4); etching through portions of the tantalum nitride layer (fig. 5); depositing a metal layer 62 of copper in the recess (fig. 6, lines 22-31), wherein the barrier layer prevents the migration of copper from the metal layer to the dielectric

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[4] Since ALD is used to deposit the metal nitride film, chemisorption of a second layer on the substrate in partial response to the second reactive gas is inherent.

[5] Since the second reactive gas is a nitrogen-containing gas, it is inherent that the first layer is a nitride layer.

layer (col. 4, lines 46-52). In one embodiment, tantalum nitride is used for the barrier layer (col. 3, lines 54-62).

While the Nogami et al. patent discloses a tantalum nitride barrier layer, Nogami et al. does not teach that the tantalum nitride is deposited using a sequential chemisorption of tantalum-containing and nitrogen-containing precursor gases.

As discussed above, Gates et al. discloses a method of depositing a metal nitride film for an integrated circuit, wherein an ALD is used to deposit the metal nitride film (col. 5, line 55 - col. 7, line 42 and col. 10, lines 25-52). In the embodiment wherein the metal nitride film is tantalum nitride, the tantalum nitride film is deposited using a sequential chemisorption of a tantalum-containing precursor gas, $Ta(NO_3)$, and a nitrogen-containing precursor gas, NH_3 (col. 10, lines 32-52). Alternating layers of tantalum and nitrogen are formed, wherein the alternating layers are formed by sequentially pulsing a tantalum-containing gas and a nitrogen-containing gas (col. 6, lines 13-21, 39-44 and col. 10, lines 32-52). A tantalum nitride film formed by this method is ideal for use as a barrier layer in interconnect structures because of the following reasons: (1) the thickness of the tantalum nitride layer is controllable, and (2) the step coverage of the tantalum nitride film is excellent within small vias and trenches (Gates et al. - col. 5, lines 17-24).

Since Gates et al. describes a method for forming a metal nitride film that is ideal for use as a barrier layer in interconnect structures and since Nogami et al. describes a

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[6] The Nogami et al. reference was relied upon in the Office action mailed on 04 Feb. 2003.

method for forming a barrier layer in an interconnect structure, the purpose disclosed by Gates et al. would have been recognized in the pertinent art of Nogami et al., at the time the invention was made, by one having ordinary skill in the art.

At the time the invention was made, one having ordinary skill in the art would have been motivated to modify the method of Nogami et al. by depositing the tantalum nitride layer 42 using a sequential chemisorption of tantalum-containing and nitrogen-containing precursor gases, as taught by Gates et al., because: (1) the thickness of a tantalum nitride layer deposited using sequential chemisorption is controllable, and (2) the step coverage of the tantalum nitride film within small vias and trenches is excellent (Gates et al. - col. 5, lines 17-24).

5. *Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami et al. in view of Gates et al. as applied to claim 24 above, and further in view of Joo et al. (US 6,124,203).*

Again, Nogami et al. discloses a step of depositing a metal layer 62 of copper in a recess (fig. 6, lines 22-31). While Nogami et al. discloses the use of copper as the metal layer, Nogami et al. do not teach that the metal layer is a refractory metal selected from titanium, tungsten, vanadium, niobium, tantalum, zirconium, hafnium, chromium, and molybdenum.

The Joo et al. patent discloses a method for forming an interconnect structure, wherein the interconnect structure comprises a barrier layer 224 (fig. 2 and accompanying text). The method comprises: providing a substrate having a dielectric layer 114, 116, 117, 108 thereon, wherein the dielectric layer has a recess 106, 118 formed

to expose a portion of a surface of the substrate (fig. 2); forming a barrier layer 224 on the dielectric layer and the substrate (fig. 2); and depositing a metal layer in the recess (not shown, col. 6, lines 41-48). While copper is the preferred metal of choice for the interconnect structure, Joo et al. teaches that tungsten may be used in place of copper as the material for the interconnect structure (col. 6, lines 55-59). In addition, Joo et al. lists tantalum nitride as a suitable material for the barrier layer 224 (col. 6, lines 20-22).

It would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the combination of Nogami et al. and Gates et al. by using tungsten in place of copper as the metal layer, as taught by Joo et al., since both copper and tungsten have low resistivity (i.e. are highly conductive), and both are compatible with tantalum nitride.

Allowable Subject Matter

6. Claims 4-8, 16-23, and 32-47 are allowed. Claims 3 and 11-15 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Toniae M. Thomas whose telephone number is (703) 305-7646. The examiner can normally be reached on Monday through Thursday, and alternating Fridays, from 8:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (703) 308-4905. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 305-3432 for regular communications and (703) 305-3432 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

JMJ
July 10, 2003

AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800